CODING ACTIVE INFERENCE

From Simple Agents to Edge Intelligence

https://github.com/cerkut/D3A-AIF-Starter

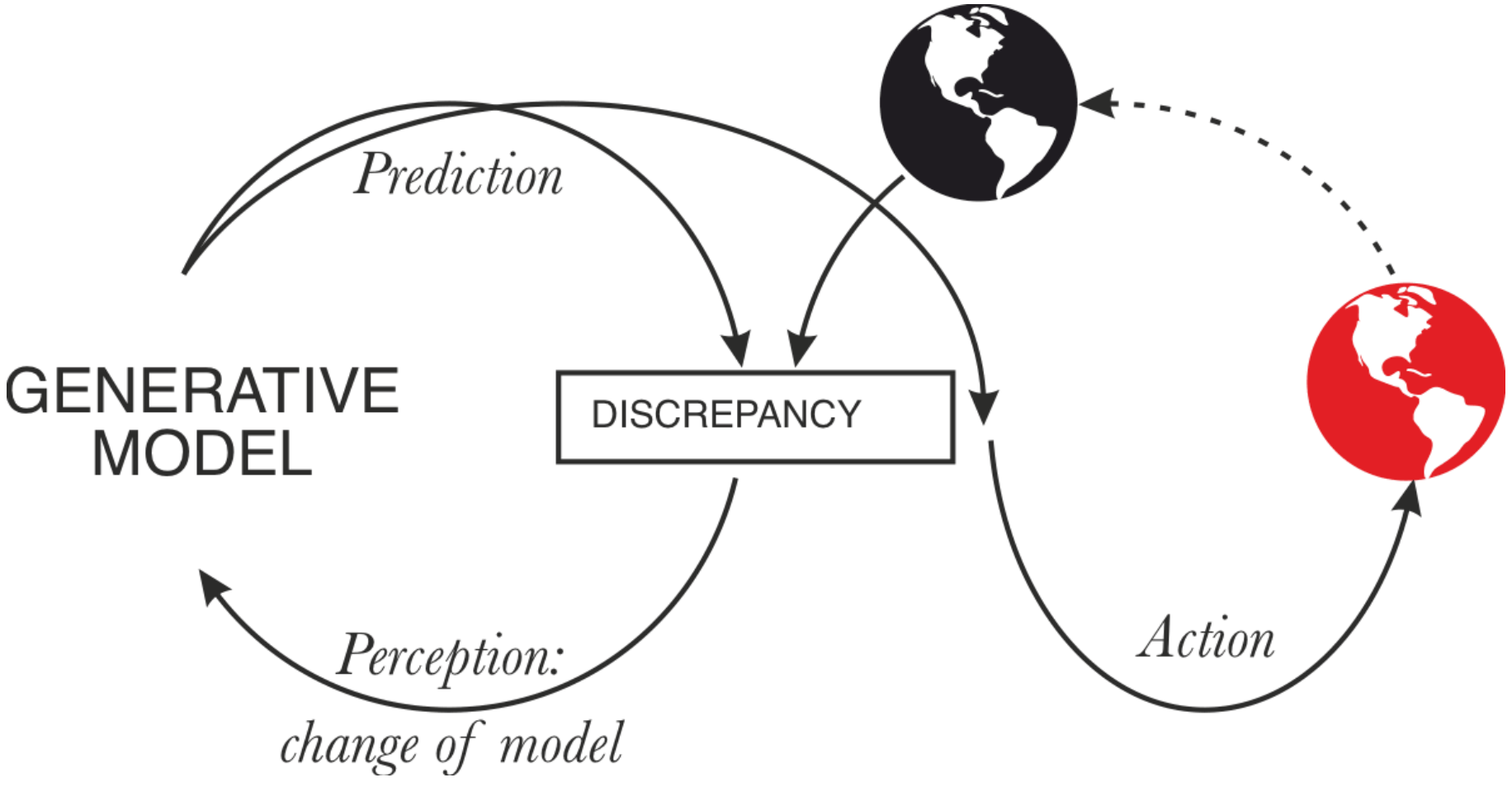
CUMHUR ERKUT

DEPT. OF ARCHITECTURE, DESIGN AND MEDIA TECHNOLOGY (CREATE)

Remember: November 13-15, 2024 https://symposium.activeinference.institute

AALBORG UNIVERSITY
DENMARK

Active Inference for Multisensory Experience

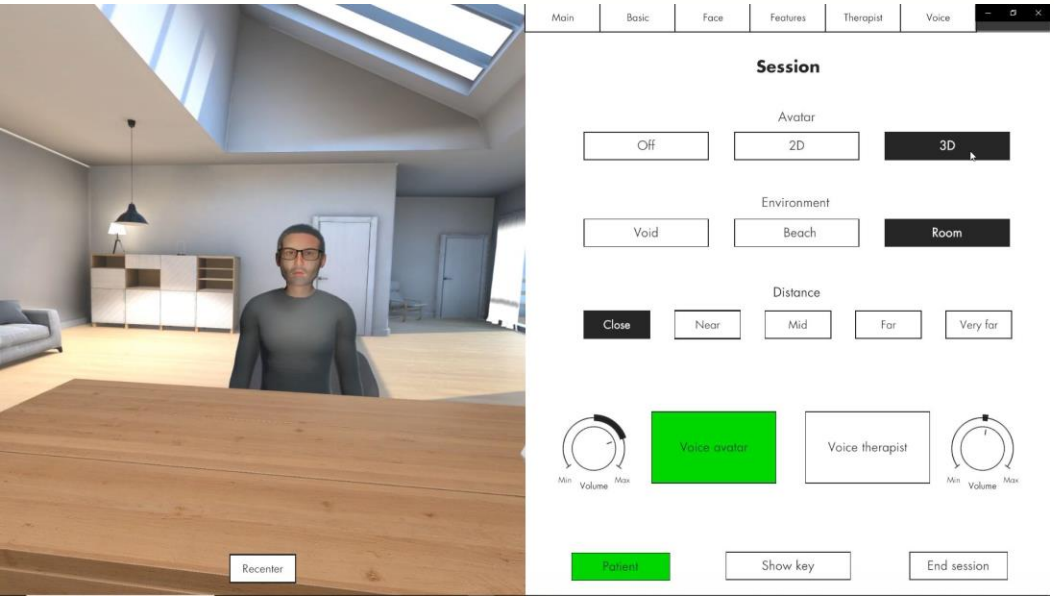


PROBLEM

30% of patients with schizophrenia treatment-resistant
Meltzer HY. (1997)

those whose symptoms get better from medication experience terrible side-effects and often discontinue taking their meds
Lieberman, J. A., et al. (2005)

This is the most expensive disease to treat in psychiatry
Kadakia A. et al, 2022, Christensen, M.K. et al, 2022, Fasseeh,A. et al., 2018,



T-shaped profile combining sound, music, and motion with AI/XR for real-time deployment with MLOps

Real-time Processing of Traditional Music with Differentiable DSP

Background: Each real—time generative model challenges us in code, model, data, and operational practices.

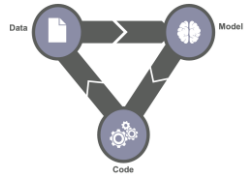
Example 1: Resurrecting Tromba Marina.
Also Flamenco, Nordic and Middle Eastern traditions.

Example 2: Generative Choreographies combining sound, music, and movement. Also therapy.

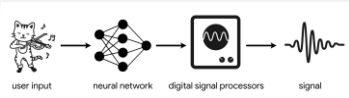
Methods

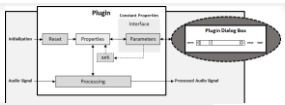
Plugins | Real-time inference | Differential Digital Signal Processing | Generative Models

1 Unique data, model, code



2 Unique MLOps around the core AI/ML





Aim: Keep the interested, motivated, and contributing graduates in Denmark

AALBORG UNIVERSITET
Cumhur Erkut, Dr. Sci (Tech)
Multisensory Experience Lab.
Copenhagen, Denmark

Towards Multimedia Edge Intelligence with Active Inference

Top: 3 scenario pilots at the lab. a) Workshop with XR-enabled EI musical instruments during a visit from University of Oslo. b) Social movement exercises with adolescents on the autism spectrum c) Movement therapy and feedback with Zed Cameras on Jetson Orin. Bottom: starting EI-enabled research instrumentation at the lab.

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POMDP generative models

***P**artially **O**bserved **M**arkov **D**ecision **P**rocess*

$$P(o_{1:T}, s_{1:T}, \pi, \phi) = P(\phi)P(s_1)P(\pi)\prod_{\tau=2}^{T} P(s_\tau \mid s_{\tau-1}, \pi; \phi)\prod_{\tau=1}^{T} P(o_\tau \mid s_\tau; \phi)$$

$P(o_t \mid s_t, \mathbf{A})$ "Observation model" "Sensory likelihood mapping"	**A**
$P(s_\tau \mid s_{\tau-1}, \pi \,.\, \mathbf{B})$ "Transition or dynamics model" "Dynamical mapping"	**B**
$P(o \mid \mathbf{C})$ "Prior over observations" "Prior preferences"	**C**
$P(s_1 \mid \mathbf{D})$ Prior over initial hidden states	**D**

POMDP generative models

Partially Observed Markov Decision Process

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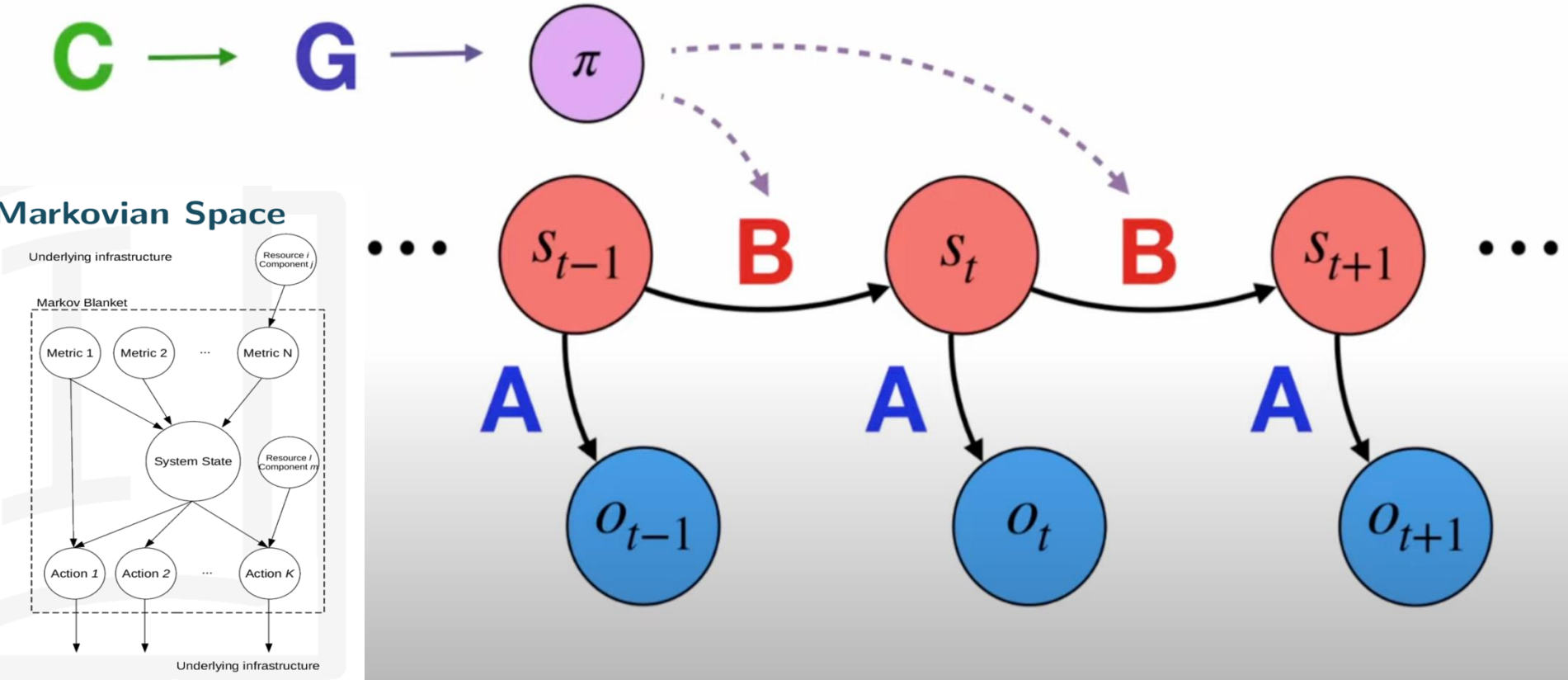

Table 3: Open Source Code for the Free Energy Principle.

	Reference	Task	Link	Language
Classical active inference	(Da Costa et al., 2020)	Linear generative model	https://www.fil.ion.ucl.ac.uk/spm	Matlab
	(Heins et al., 2022)	Discrete state space	https://github.com/infer-actively/pymdp	Python
	(Sajid, Ball et al., 2021)	FrozenLake	https://github.com/ucbtns/dai	Python
Deep active inference	(Ueltzhöffer, 2018)	MountainCar	https://github.com/kaiu85/deepAI_paper	Python
	(Fountas et al., 2020)	Dynamic dSprites & Animal-AI	https://github.com/zfountas/deep-active-inference-mc	Python
	(van der Himst & Lanillos, 2020)	CartPole	https://github.com/Grottoh/Deep-Active-Inference-for-Partially-Observable-MDPs	Python
	(Millidge, 2019)	CartPole	https://github.com/BerenMillidge/DeepActiveInference	Python
	(Rood et al., 2020)	Rubber hand illusion	https://github.com/thomasroodnl/active-inference-rhi	Python
Robotics	(Sancaktar et al., 2020)	Nao robot	https://github.com/cansu97/PixelAI	Python
	(Pezzato et al., 2020)	Panda robot	https://github.com/cpezzato/panda_simulation	Matlab
	(Pezzato et al., 2023)	TIAGo robot	https://github.com/cpezzato/discrete_active_inference	Python & Matlab
	(Baioumy, Duckworth et al., 2021)	Panda robot	https://github.com/MoBaioumy/active_inference_panda_paper	Python
	(Baltieri & Buckley, 2020)	Panda robot	https://github.com/mbaltieri/GeneralisedFiltering	Python
	(Matsumoto & Tani, 2020)	Controller	https://github.com/oist-cnru/GLean	Python
	(Meo & Lanillos, 2021)	Panda robots	https://github.com/Cmeo97/MAIF	Python
	(Baioumy, Pezzato et al., 2021)	Controller	https://github.com/cpezzato/unbiased_aic	C++

Zhang, Zhengquan, and Feng Xu. 2024. “An Overview of the Free Energy Principle and Related Research.” Neural Computation 36 (5): 963–1021. doi:10.1162/neco_a_01642.

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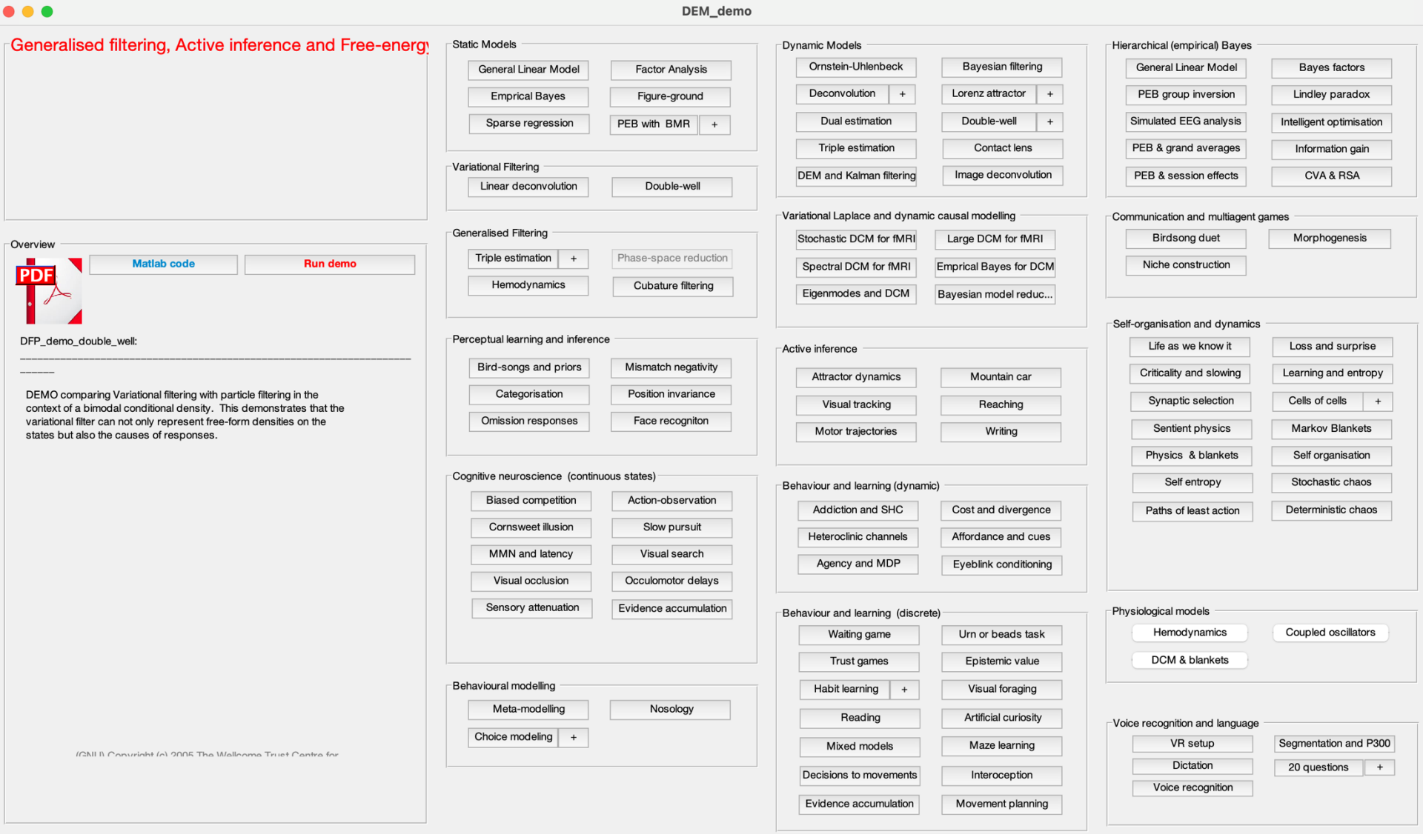

Classic SPM/DEM: https://www.fil.ion.ucl.ac.uk/spm/doc/papers/DEM_A_variational_treatment_of_dynamic_systems.pdf

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Note that the table does not enlist Reactive Message Passing (Julia): https://github.com/ReactiveBayes
Nor https://github.com/ilabcode/ActiveInference.jl

Overview of today's material

A, B, C, D

Make an active inference agent using `Agent(A = A, B = B, C = C, D = D)`

Specify a task environment (i.e. an `env()` class)

Run active inference loop!

Insert Web Page

This app allows you to insert secure web pages starting with https:// into the slide deck. Non-secure web pages are not supported for security reasons.

Please enter the URL below.

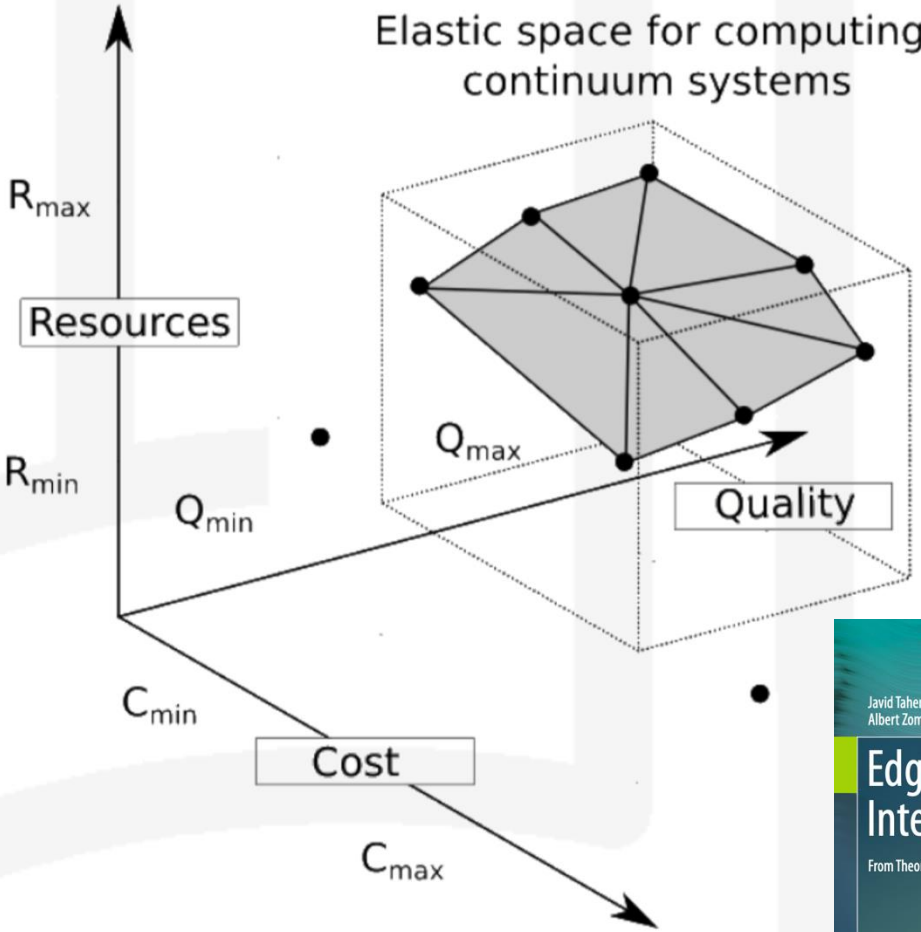
https:// pymdp-rtd.readthedocs.io

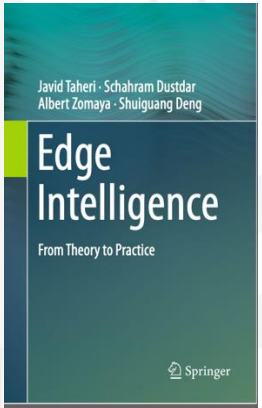
Note: Many popular websites allow secure access. Please click on the preview button to ensure the web page is accessible.

Preview

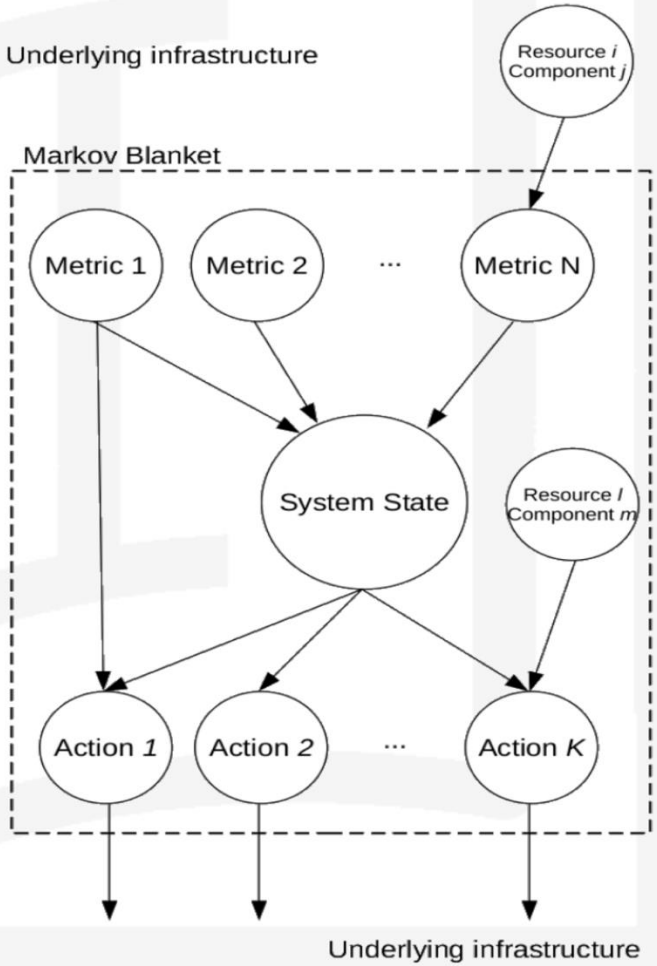
Cartesian Blanket

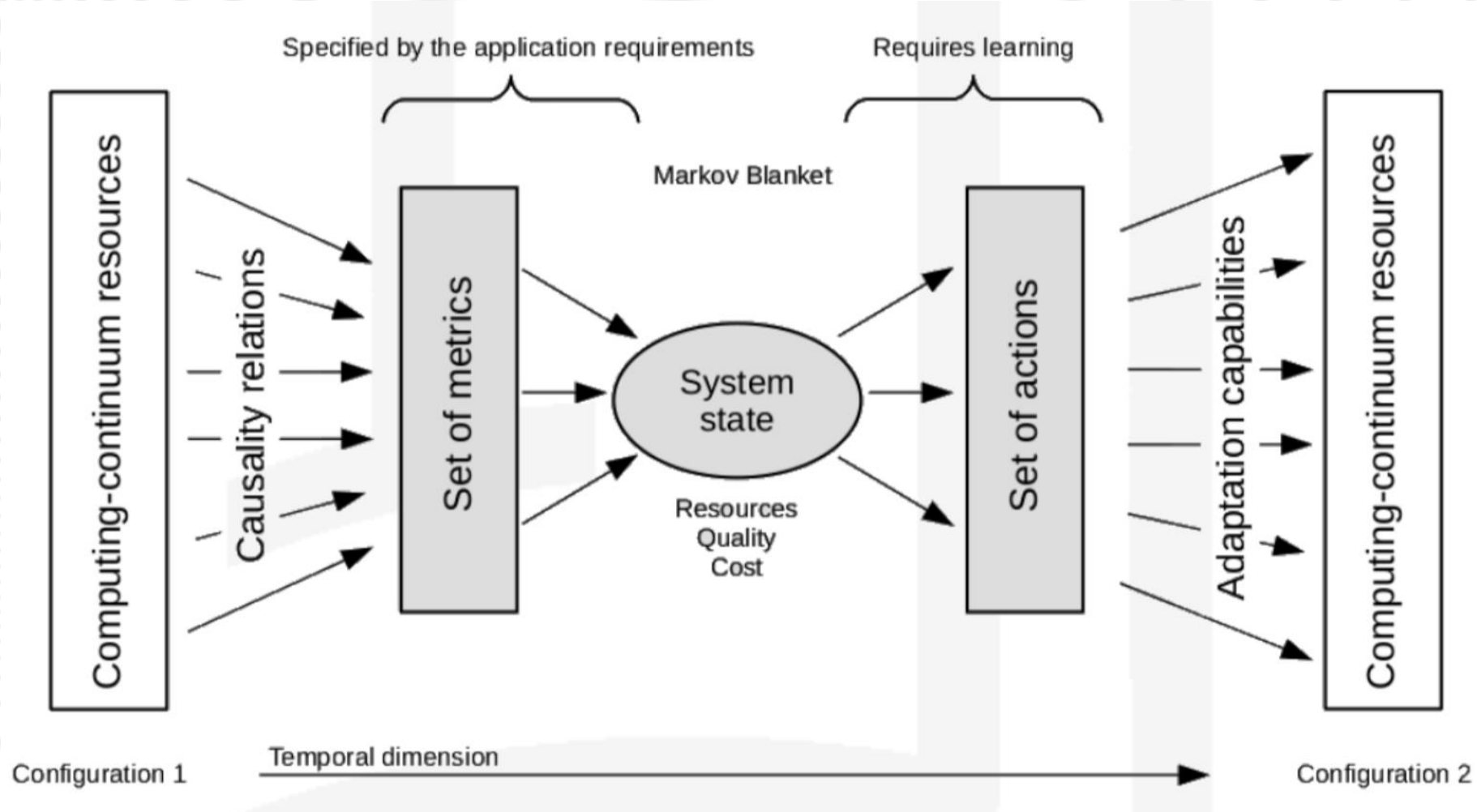
Elastic space for computing-continuum systems



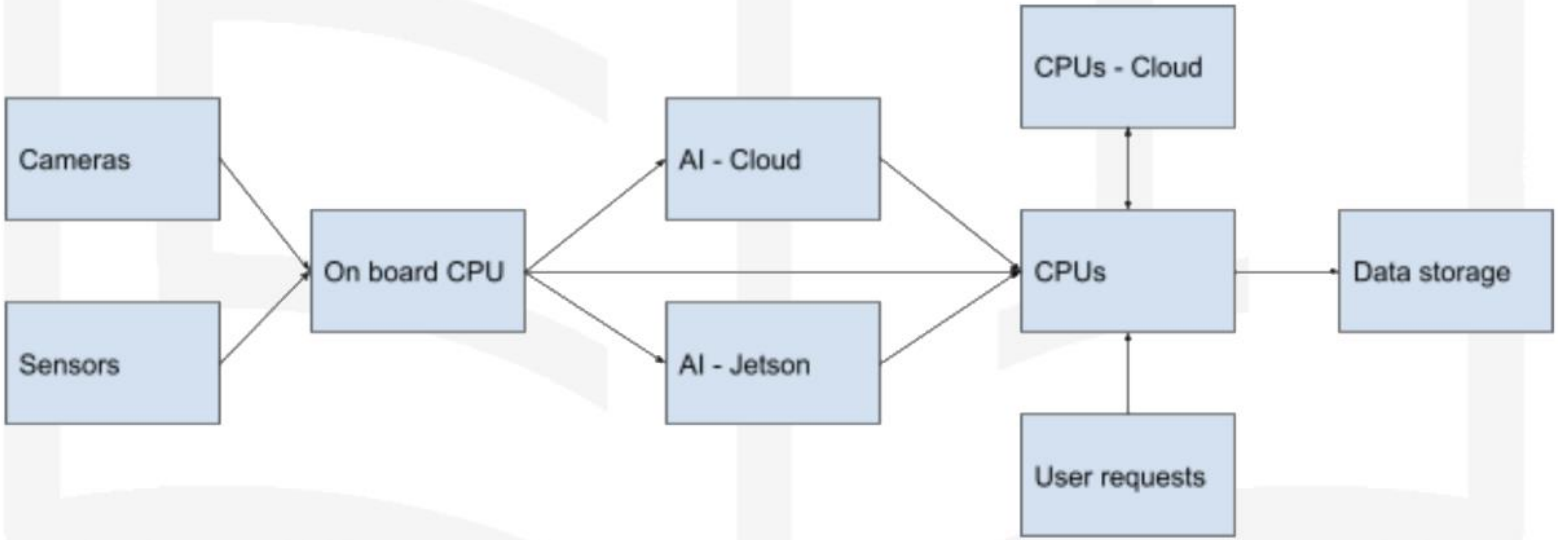


Markovian Space

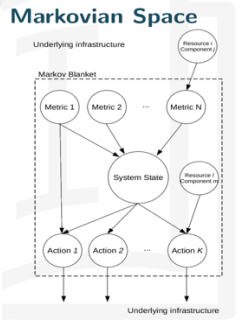



Specified by the application requirements
Requires learning
Markov Blanket
Computing-continuum resources
Causality relations
Set of metrics
System state
Resources
Quality
Cost
Set of actions
Adaptation capabilities
Computing-continuum resources
Configuration 1
Temporal dimension
Configuration 2

Application Description



Developing the DAG



Weather condition
light condition
Frame resolution
Frame rate
Cameras in use
Video quality
Inference model
Offloaded instances
Operation time
Devices ping
Count Sensor data
Radar data
Sensors cont. stream
Overall test signal
Privacy measures
Privacy concern
Devices in use
% identified drivers
% identified drivers at 2VI
Privacy level
% Cloud usage
Expected remaining Energy
System's up time
Quality
Cost
Resources